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12-14 June 2007, at US Naval Academy, Annapolis, MD

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Headquarters U.S. Air Force

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Developing Masking Guidance With Respect to BW Trigger Events



Military Operations Research Society Symposium

Presented by: Dan Cinotti

Sponsoring Organization: HQ AF/A3SC

14 June 2007

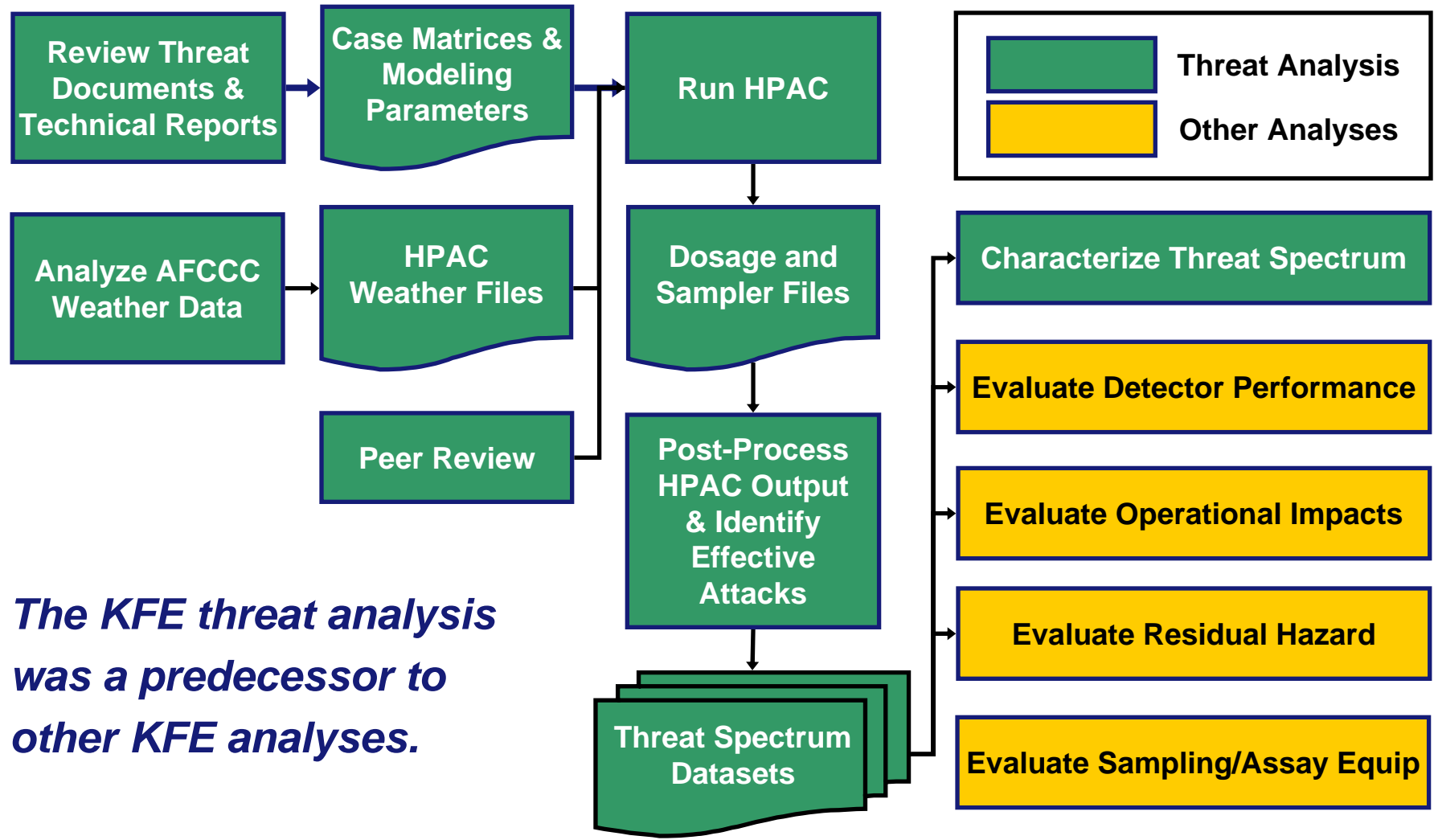


KFE Analytic Approach

- **Estimate BW hazard environment**
 - Threat analysis: plausible weapons, agents, and weather
 - Use HPAC to model atmospheric transport and dispersion of agent for each plausible attack scenario
 - Reject non-effective attacks → Threat Spectrum
- **Evaluate equipment / procedure performance against each attack in the threat spectrum**
- **Determine how much of the threat spectrum is covered by equipment or procedures that are adequate/inadequate**
- **Develop / adjust ConOps accordingly**



Overview of KFE Threat Analysis





KFE Delivery Systems, Agents, and Weather Conditions

5 Delivery Systems	7 Agents	9 Weather Conditions	Other Key Attack Parameters
<ul style="list-style-type: none">■ TBM (bulk)■ TBM (submunitions)■ Ground/Sea-based Sprayer (mobile)■ Aerial Sprayer (mobile)■ Backpack Sprayer (stationary)	<ul style="list-style-type: none">ANTHRYQ	<ul style="list-style-type: none">■ 3 seasons:<ul style="list-style-type: none">- Summer- Winter- Fall/Spring■ 3 times of day:<ul style="list-style-type: none">- 0500L- 1200L- 2200L	<ul style="list-style-type: none">■ Stand-off distance■ Source strength■ Number of munitions■ Footprint radius (TBMs with submunitions)

A case matrix was developed for each delivery system. Each matrix:

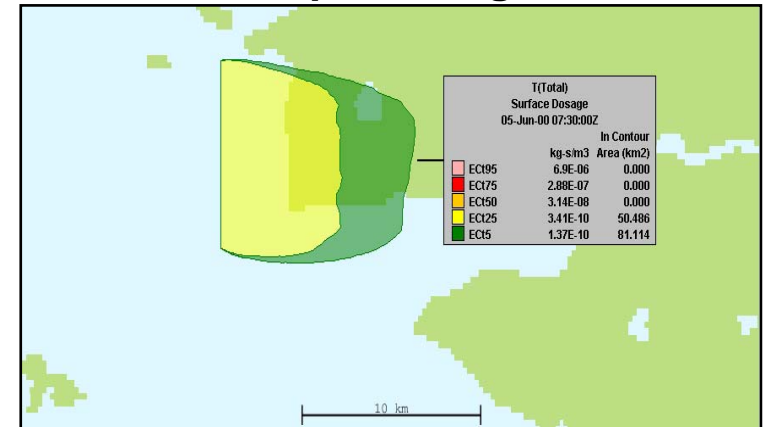
- ***Specifies the combinations of attack parameters to be modeled***
- ***Determines the total number of computer simulations required***



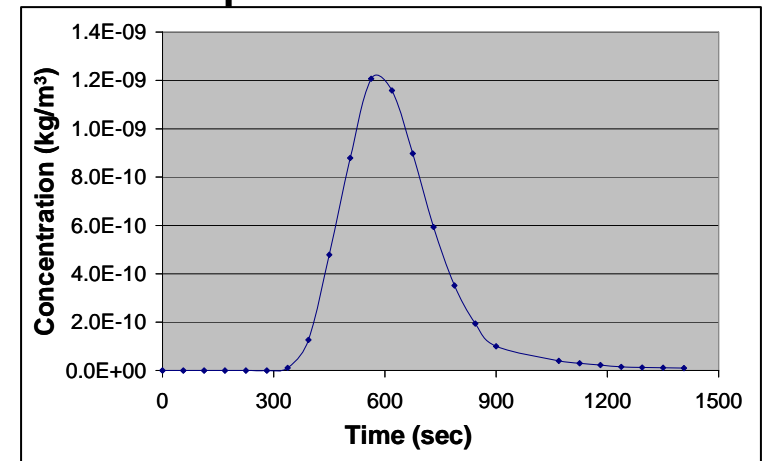
Modeling the Atmospheric Dispersion of BW Agents

- Hazard Prediction and Assessment Capability (HPAC), v 4.04 was used to model atmospheric transport and dispersion (ATD) of BW agents
- For a given BW attack scenario, HPAC models dispersion of particles in the atmosphere, and estimates:
 - The dosage resulting from primary inhalation of BW agent
 - The concentration of BW agent over time at a specific location, (i.e., what a detector would “see”)

Example Dosage Plot



Example Concentration Profile





BW Masking Analysis Objective

Use KFE threat spectrum data to develop BW masking guidance for weapon and detector events

- *Is it beneficial to mask when a bio detector alarms, or has the cloud already dissipated?*
- *When should personnel don/doff masks with respect to various trigger events?*
 - Intel
 - ✓ Weapon Event
 - ✓ Detector Alarm
 - Sentinel Casualties



BW Masking Analysis Technical Approach

- Simulate performance of BW point detectors installed at Kunsan AB
 - Trigger
 - Sampler
 - Identification technology (immunoassay)
 - Alarm Criteria
- Challenge point detectors with attacks (concentration profiles) in the KFE Threat Spectrum
- Develop guidance for donning / doffing masks that would minimize the percentage of attacks exceeding a particular risk level

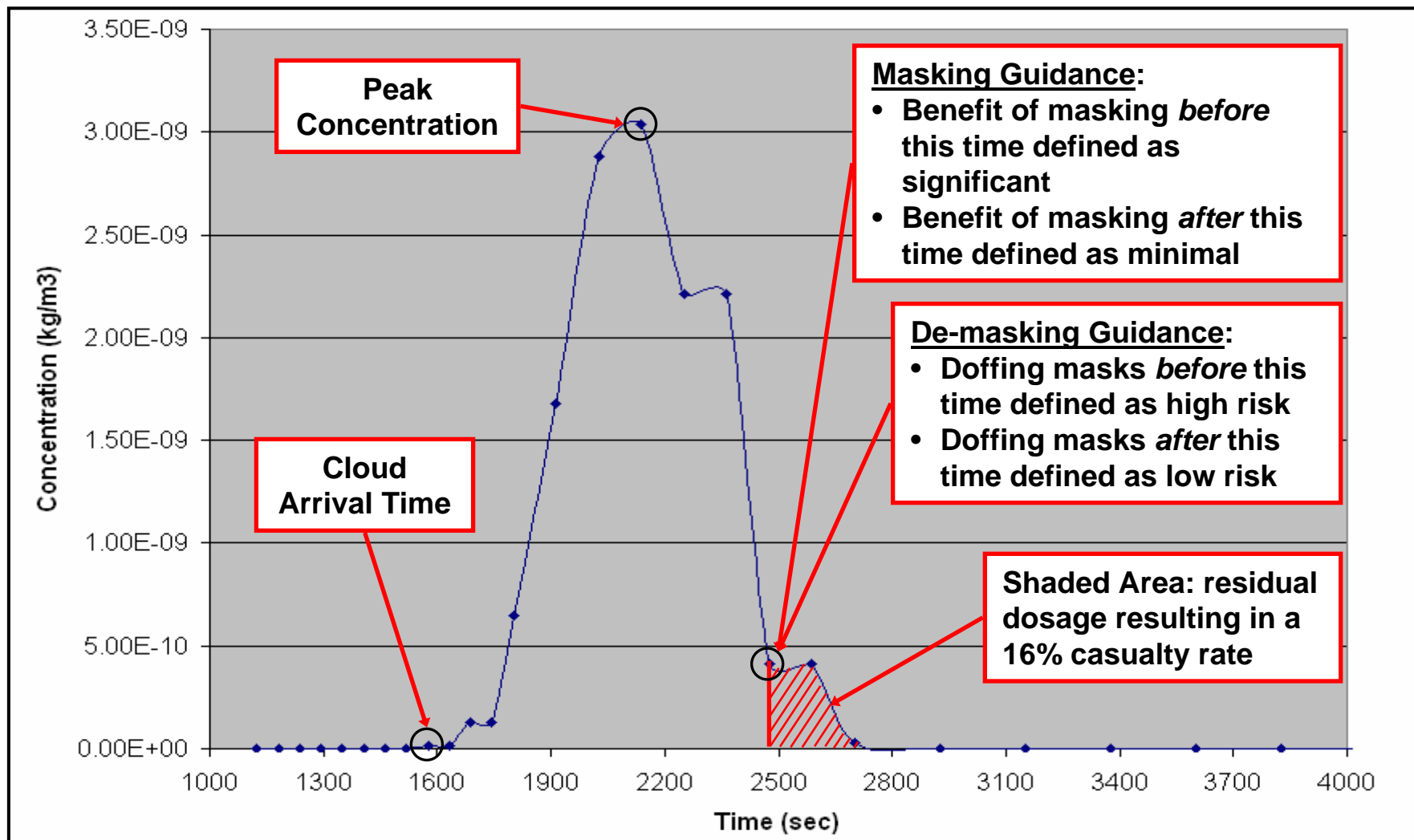


Useful Definitions

- **Trigger Events (listed on the previous slide)**
 - Discrete events that *trigger* specific decisions / actions
- **Detector Trigger**
 - A device that turns on an air sampler, typically by detecting an increase in aerosol concentration
- **Automatic Identification (Auto-ID)**
 - Occurs when agent is identified in a sample that was automatically collected by Portal Shield operated in Smart Mode
- **Network Alarm (Alarm)**
 - Occurs when auto-ID occurs at 2 or more Portal Shields
- **Manual Identification (Manual-ID)**
 - Occurs when Auto-ID is corroborated by HHA using caddies with a different lot number



Chronology of Cloud Passage



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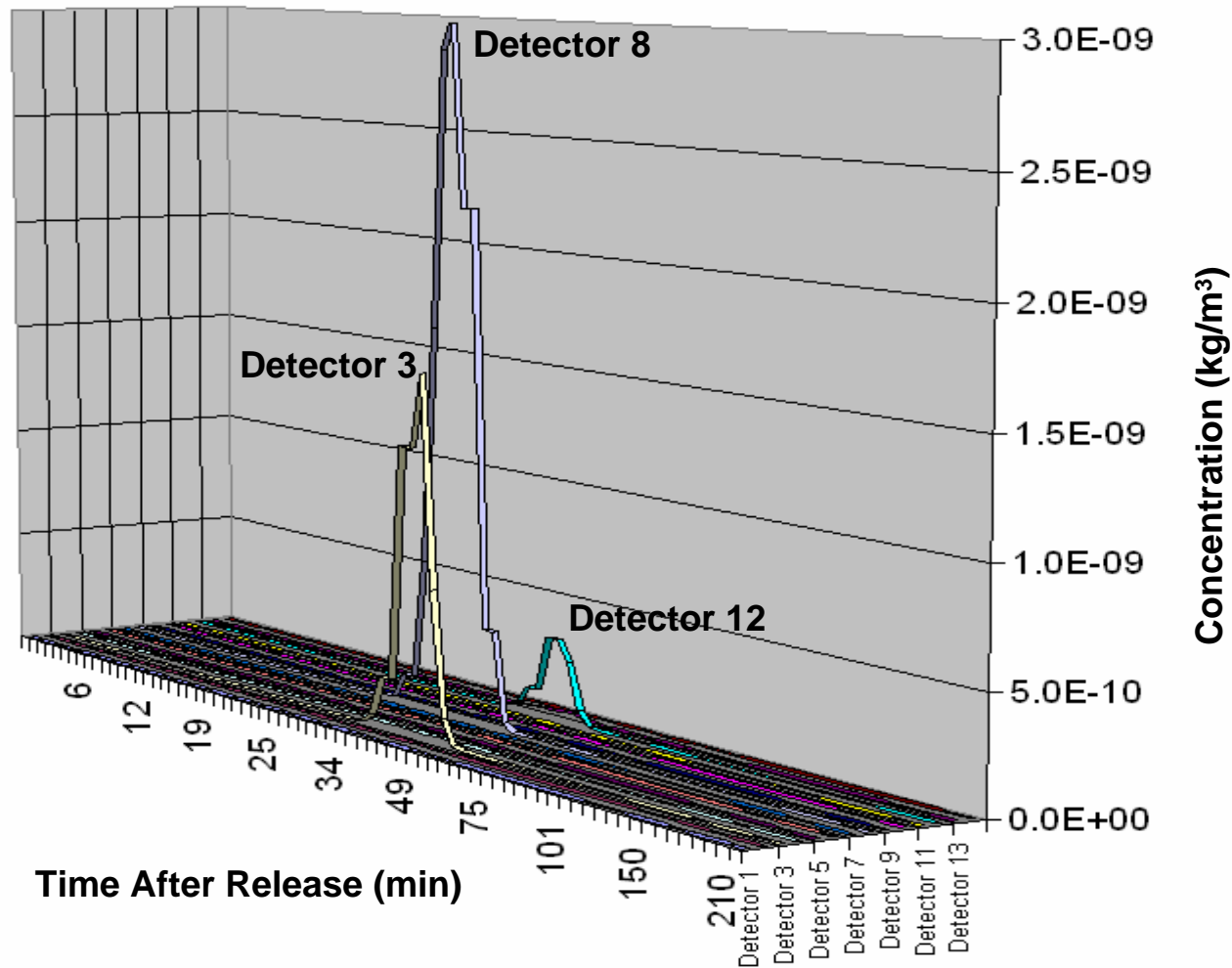


“Time After Which Dosage is Less than the ECt_{16} ”

- ECt_{16} is the dosage level at which 16% (aprox. 1/6) of an exposed population are expected to be incapacitated
- Was not correlated to operational consequences on an air base
- If a detector alarms when the remaining dosage is less than the ECt_{16} , the benefit from masking at that location is relatively small
 - Personnel near that detector may already be infected
- The benefit from masking at other locations, however, may be significant (i.e., the remaining dosage may exceed the ECt_{16})




Sample Concentration Profile for 14 BW Point Detectors at Kunsan AB




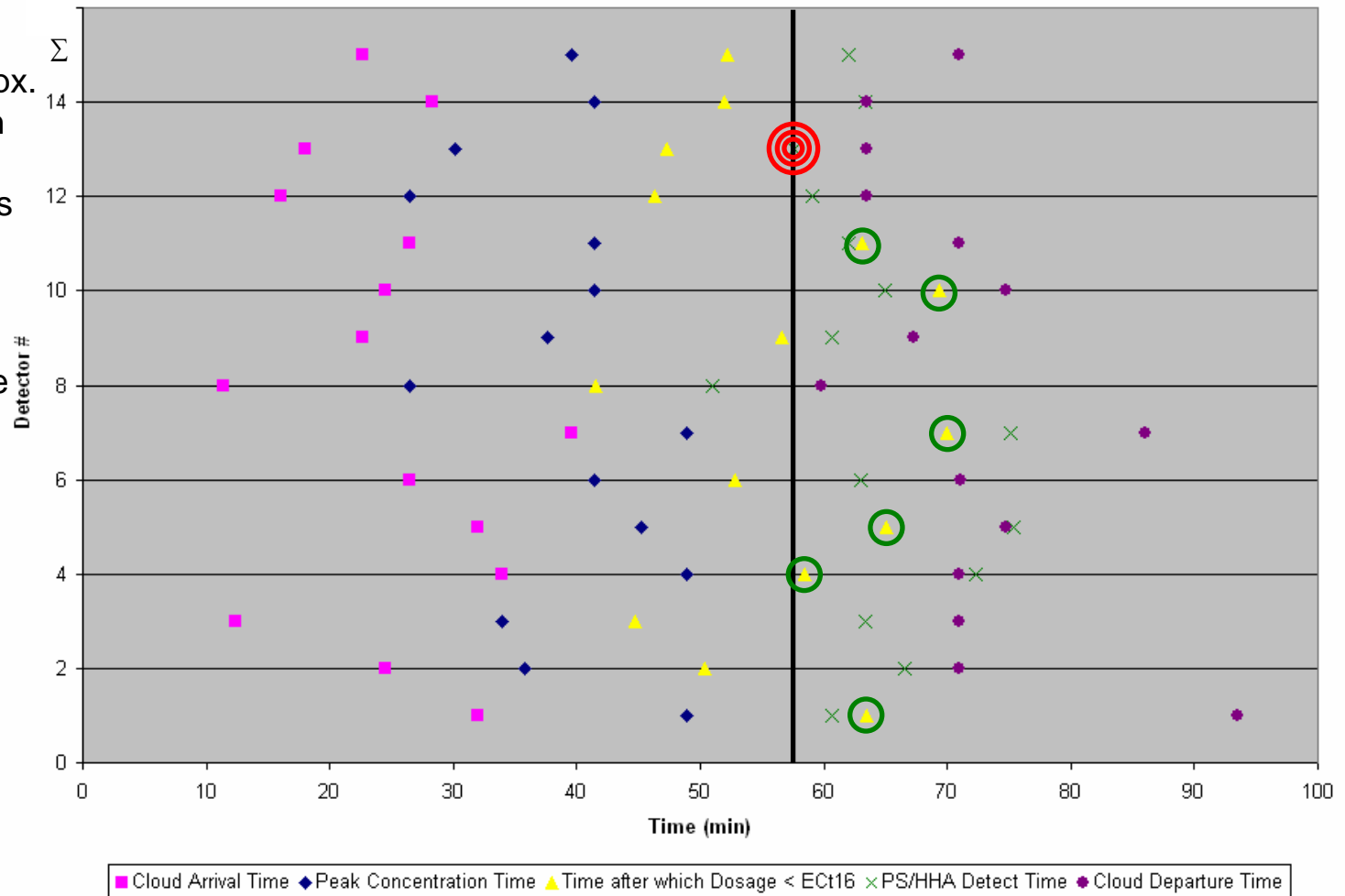
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Detector Chronology (1)

 The second auto-ID occurs at Detector 13 apx. 58 min after the weapon event; the residual dosage at this location is less than the ECt_{16}

 But there are 6 other detector locations where the remaining dosage exceeds the ECt_{16}

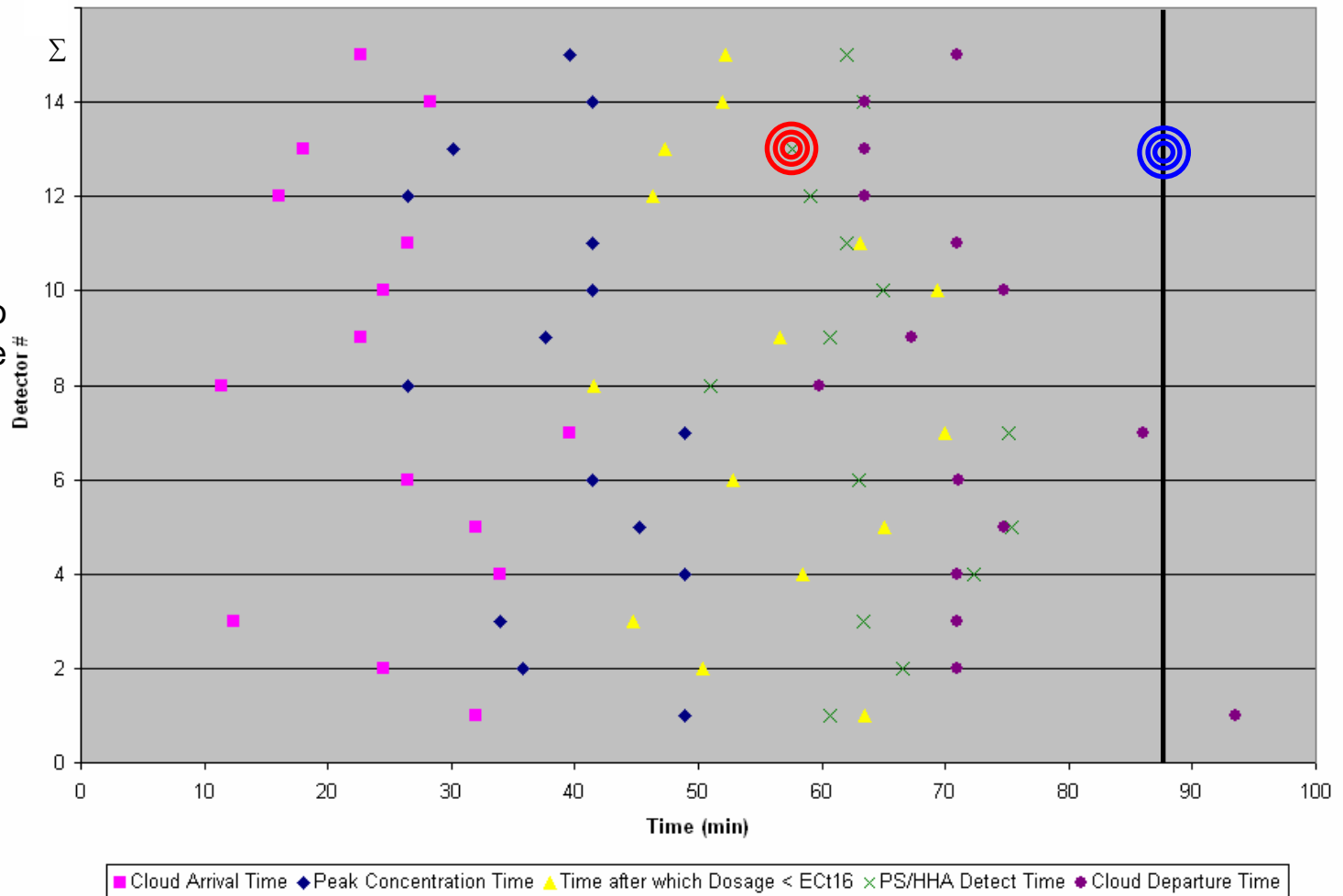




Detector Chronology (2)

Manual ID by HHA (on the sample from detector 13) occurs apx. 30 minutes after the second auto-ID

By this time there are no detector locations where the remaining dosage exceeds ECt_{16}



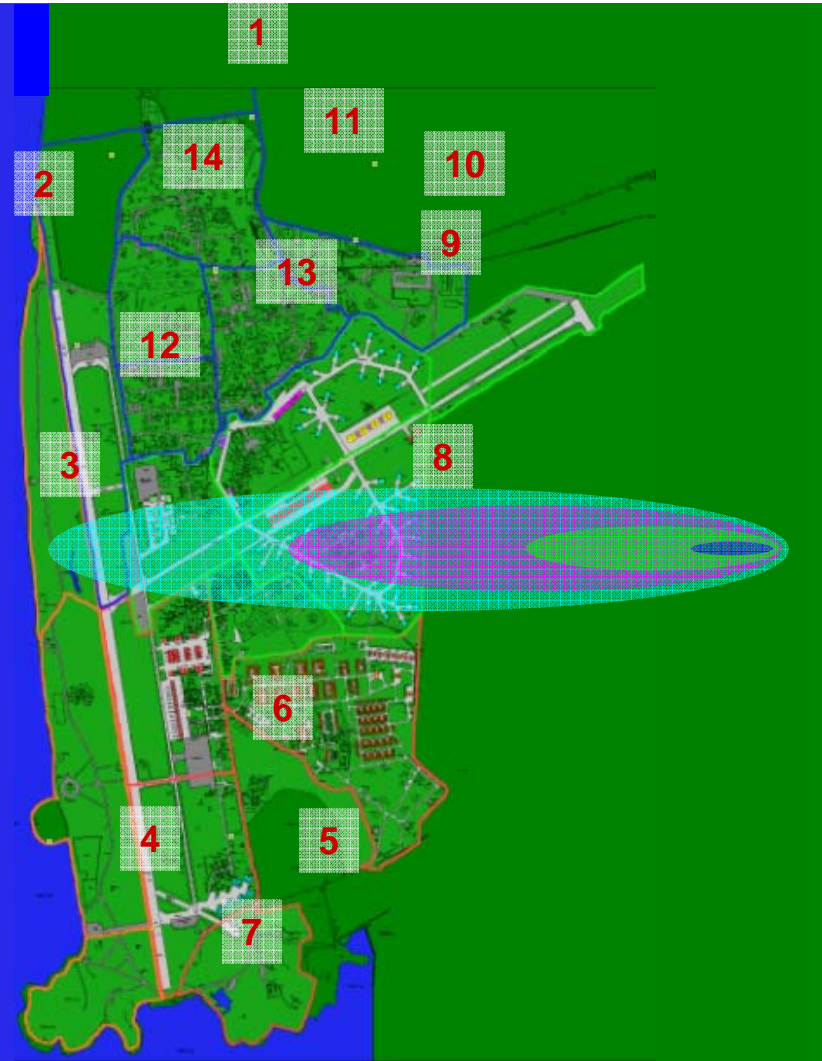


Notional Back Pack Spray Attack on Kunsan AB (1)

- At this time, the aerosol cloud has arrived, but has not yet triggered sample collection or agent identification at any of the 14 BW point detectors



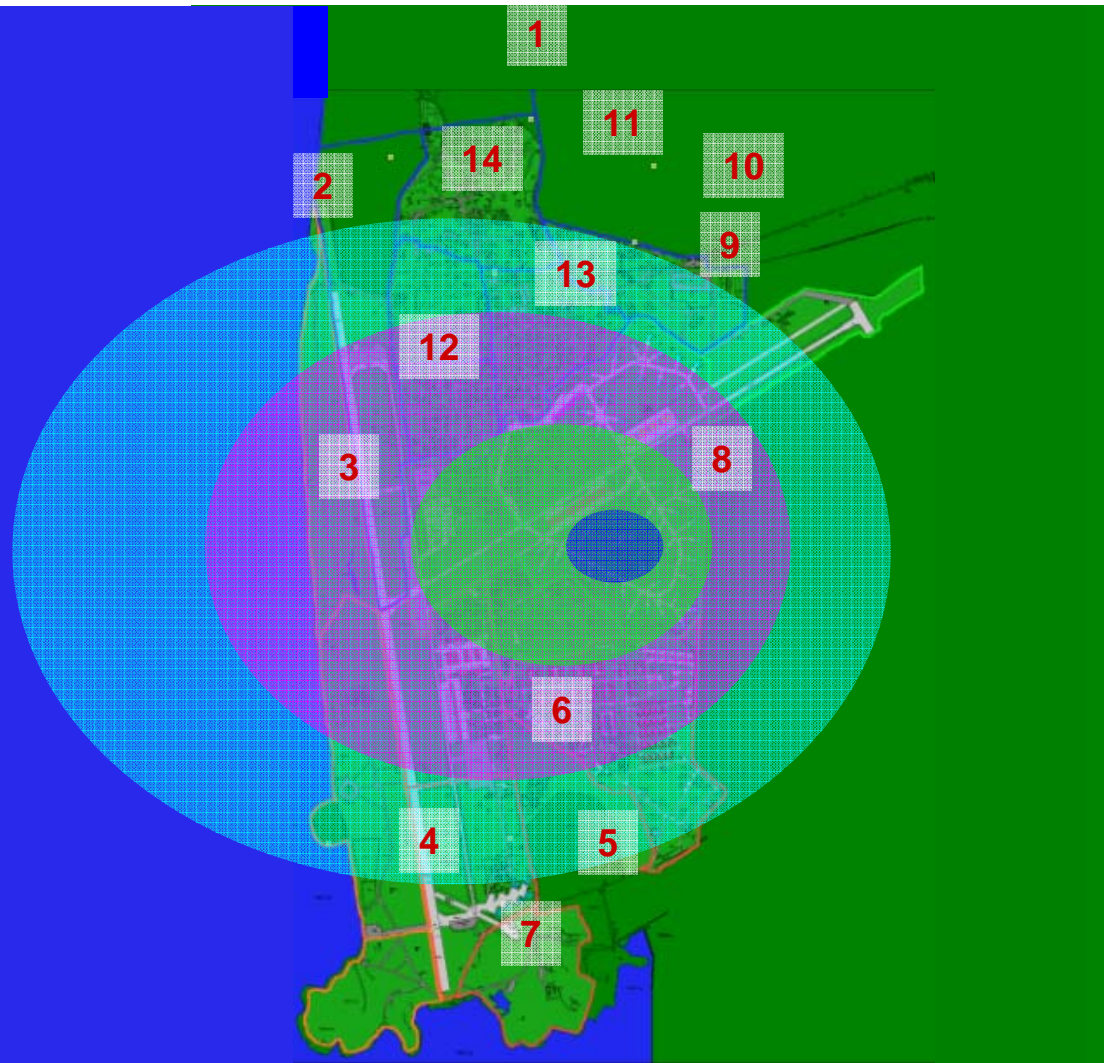
Detector Locations





Notional Back Pack Spray Attack on Kunsan AB (2)

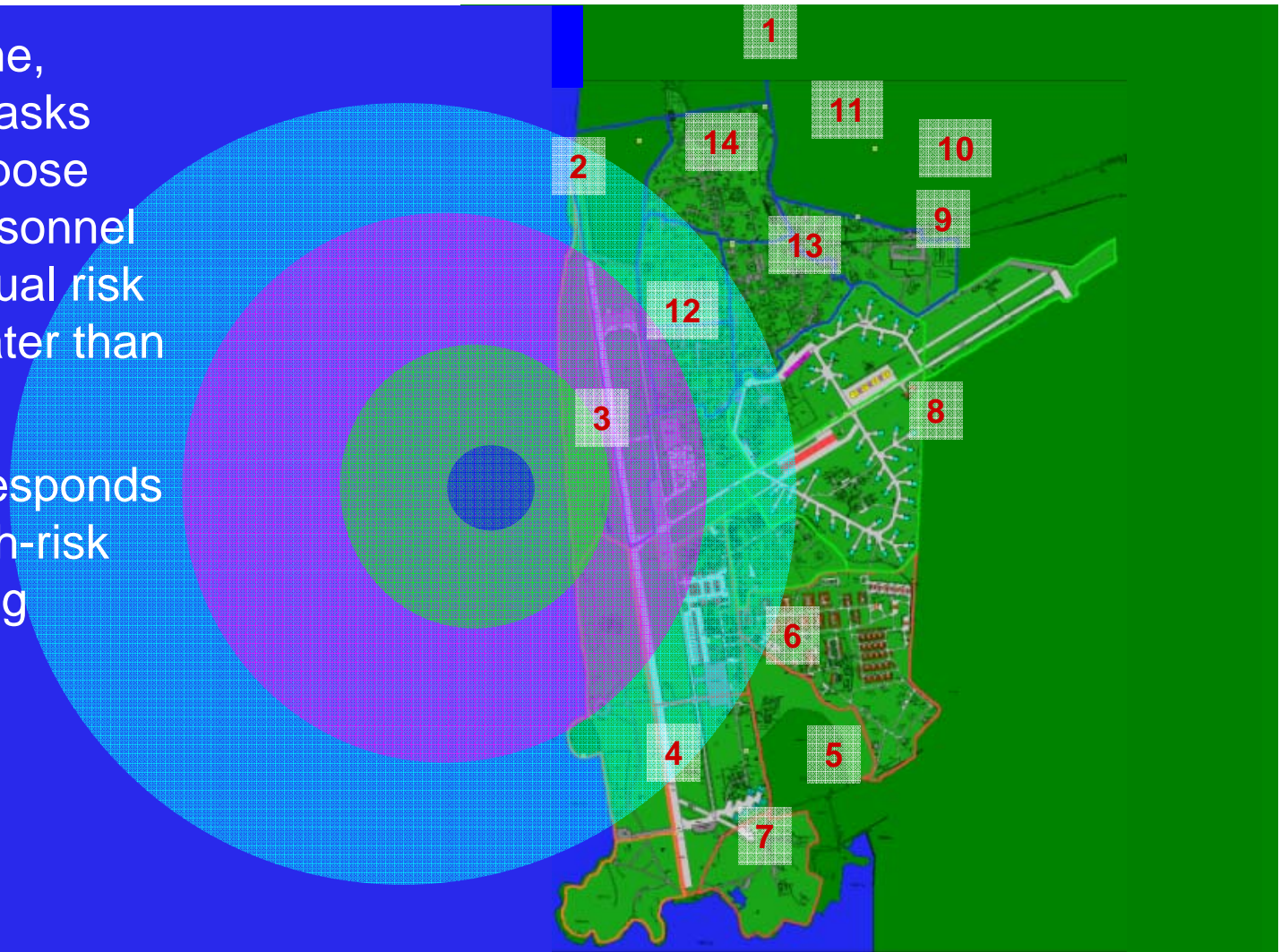
- At this time, the aerosol cloud has identified agent at 2 or more detectors resulting in a detector alarm.
- Some personnel may have already been exposed to an effective dose.
- Others would benefit from donning their mask.





Notional Back Pack Spray Attack on Kunsan AB (3)

- At this time, doffing masks would expose some personnel to a residual risk level greater than 16%.
- This corresponds to the high-risk demasking guidance.





Notional Back Pack Spray Attack on Kunsan AB (4)

- At this time, the aerosol cloud has mostly dissipated.
- Doffing masks at this time is not expected to expose personnel to a residual risk level greater than 16%.
- This corresponds to the low-risk demasking guidance.





Tolerance for Risk

- **Risk is based on the likelihood that masking or de-masking will protect against a remaining dosage greater than the ECT_{16}**
 - Says nothing about the dosage received prior to masking
- **Masking guidance was developed for two risk levels:**
 - Lower risk guidance is protective (at the ECT_{16} risk level) for *all* attacks in the KFE Threat Spectrum
 - Higher risk guidance is protective (at the ECT_{16} risk level) for *most* attacks in the KFE Threat Spectrum
- **Higher risk guidance equates to masking later or de-masking sooner than the lower risk guidance**
- **Higher risk guidance might be justified if ops tempo is high:**
 - Mission more likely to succeed, but with more expected casualties



Masking Guidance Conceptual

Masking / De-masking Guidance can be organized by trigger event and tolerance for risk

Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



Masking Guidance

Weapon Event: Lower Risk

Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



Masking Guidance Weapon Event: Lower Risk

- Current guidance is to *mask* after an observed weapon event
- But when is it safe to *de-mask*?



De-Masking Guidance

Weapon Event: Lower Risk

Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



De-Masking Guidance

Weapon Event: Lower Risk

- When is it safe to *de-mask* after an observed weapon event? That is...
- How long might a bio cloud remain *hazardous* (remaining dosage > ECt₁₆) after an observed
 - Sprayer attack? ~ 5 hours
 - TBM Attack? ~ 4 hours
- De-masking sooner may be appropriate if:
 - Testing confirms that the weapon event was not CBW
 - Personnel are adequately protected by ColPro, vaccination or prophylaxis **OR...**
 - Ops tempo is high

KFE Data		
Source Type	Agent Code	Max Time (hrs) After Which Remaining Dosage < ECt ₁₆ (Across All Detectors)
Sprayer Attacks	A	4.65
	H	4.74
	N	4.66
	Q	2.87
	R	4.74
	T	4.74
	Y	4.74
	Total	4.74
TBM Attacks	A	3.88
	H	3.99
	N	3.93
	Q	1.27
	R	3.95
	T	3.98
	Y	3.99
	Total	3.99
All Attacks	A	4.65
	H	4.74
	N	4.66
	Q	2.87
	R	4.74
	T	4.74
	Y	4.74
	Total	4.74



De-Masking Guidance

Weapon Event: Higher Risk

Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		

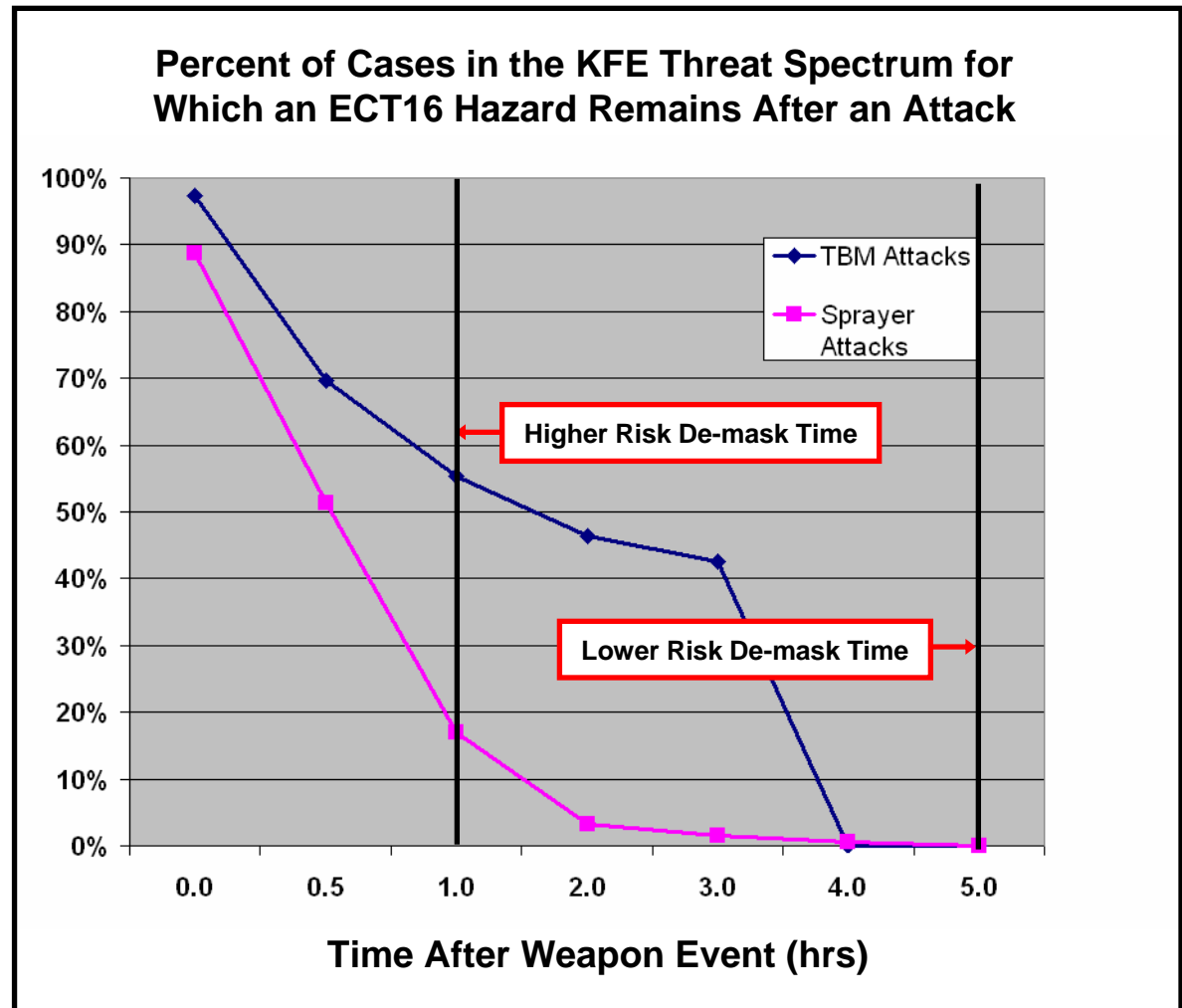


De-Masking Guidance

Weapon Event: Higher Risk

De-masking sooner may be appropriate if the ops tempo justifies a higher tolerance for risk

- De-masking sooner than 4 hrs increases the likelihood of being exposed to a residual dosage greater than the ECT_{16}
- The risk from de-masking sooner than 4 hrs after an attack increases more gradually for sprayer attacks than for TBM attacks





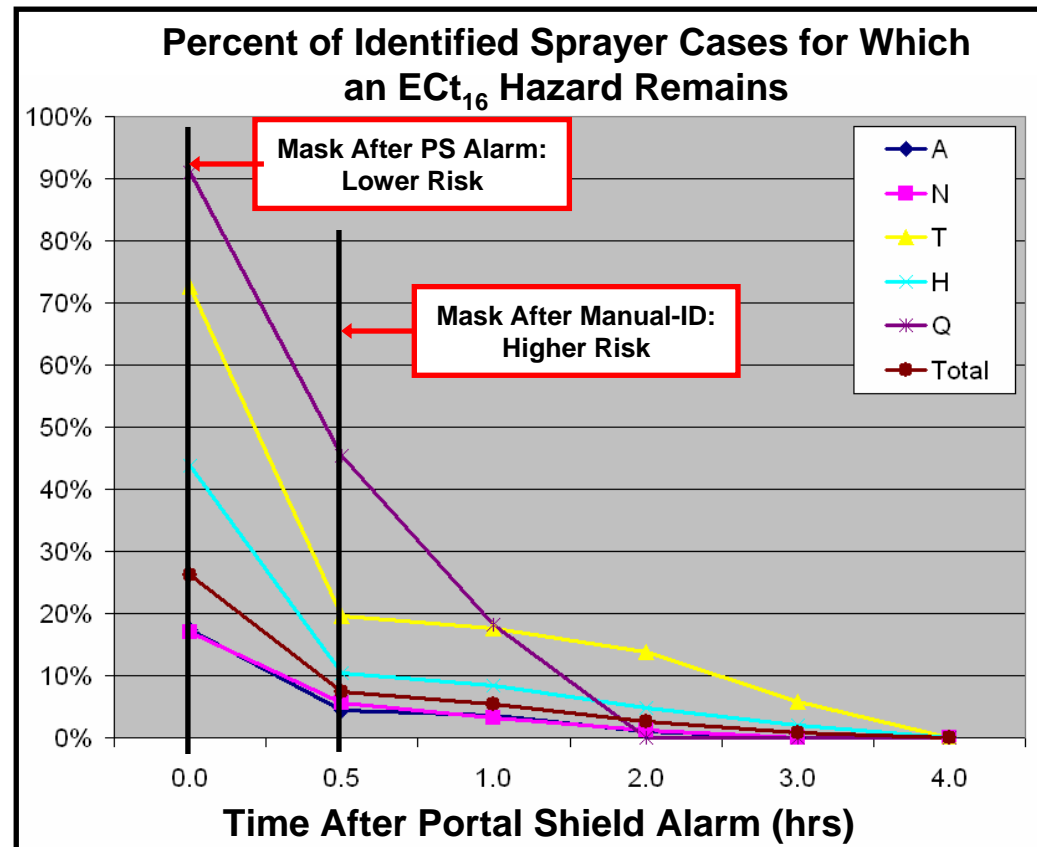
Masking Guidance Detector Event

Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



Masking Guidance Detector Event

- For observed weapon events, it is assumed that personnel will have already masked
- No current guidance exists indicating when personnel should mask in relation to a Portal Shield alarm
- The likelihood that a hazard remains after a detector alarm is time and agent dependent:
- Masking after a PS alarm is significantly more protective than masking after manual ID, particularly for agents Q and T



Two sides of the same coin: Masking after manual ID increases the likelihood that personnel will have already been exposed to a significant hazard, and decreases the likelihood that a significant hazard remains



De-Masking Guidance

Detector Event: Low vs High Risk

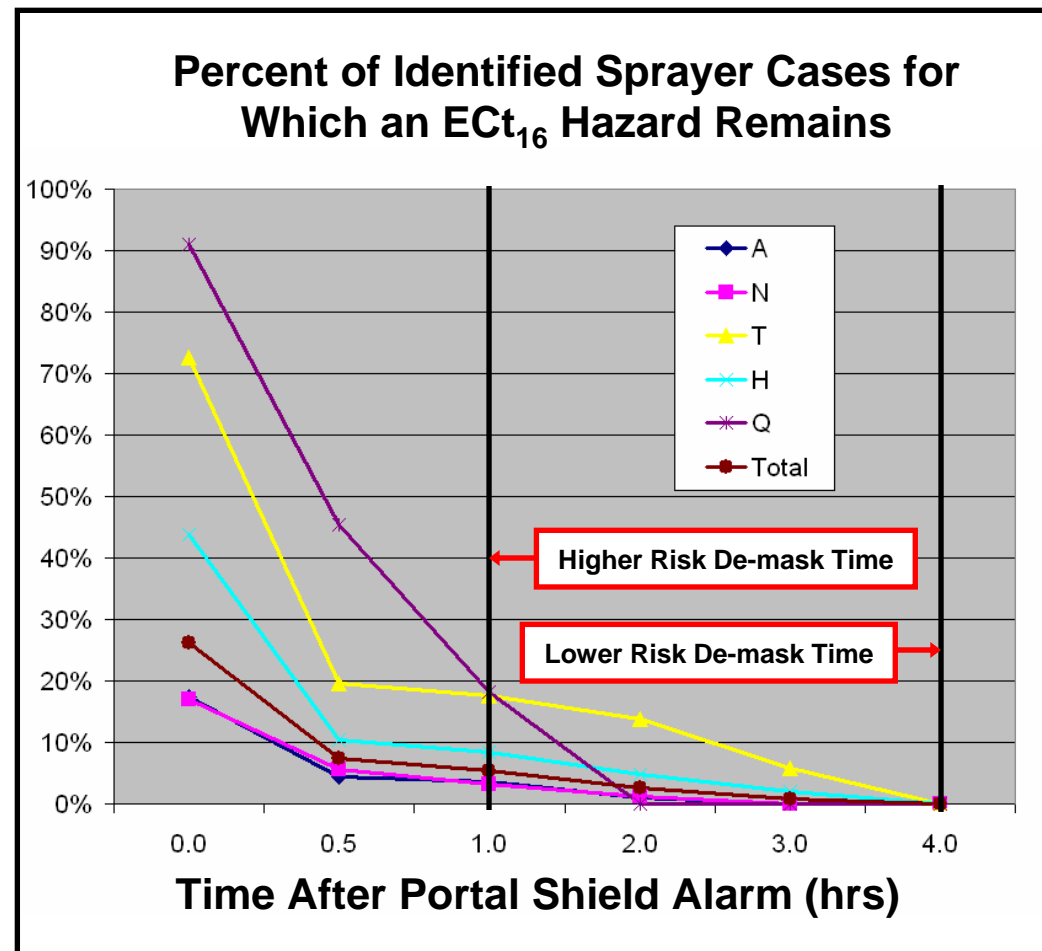
Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



De-Masking Guidance

Detector Event: Low vs High Risk

- For all identified spray attacks, the remaining dosage 4 hrs after alarm is less than the EC_{16}
- De-masking sooner than 4 hrs after alarm increases the likelihood of being exposed to a residual dosage greater than the EC_{16}
- The risk from de-masking less than 1 hr after alarm increases most significantly for agent Q
- De-masking sooner may be appropriate if:
 - Ops tempo is high
 - Personnel are adequately protected by vaccination or prophylaxis





Masking Guidance Matrix

Trigger Event		Don Mask	Doff Mask: Low Risk ^a	Doff Mask: High Risk ^b
Intel		Guidance for masking after intelligence events was not supported by the KFE dataset.		
Weapon Event	TBM	Immediately after declaration of Alarm Red (Alarm Blue in Korea)	<ul style="list-style-type: none">• 4 hrs after observed attack, OR• If surface samples near point of impact test negative	<ul style="list-style-type: none">• 3 hrs after observed attack, OR• If surface samples near point of impact test negative
	Sprayer	Immediately after declaration of Alarm Red (Alarm Blue in Korea)	<ul style="list-style-type: none">• 5 hrs after observed attack	<ul style="list-style-type: none">• 1 hrs after observed attack
Detector Alarm (Covert Attacks)		Immediately after a Portal Shield system alarm ^c	<ul style="list-style-type: none">• 4 hrs after Portal Shield system alarm ^c, OR• If personnel are adequately protected by vaccination or prophylaxis	<ul style="list-style-type: none">• 1 hr after Portal Shield system alarm ^c, OR• If personnel are adequately protected by vaccination or prophylaxis
Sentinel Casualties		Guidance for masking after sentinel casualties was not supported by the KFE dataset.		
NOTES: a. Low risk: a dosage > EC _{t16} did not occur after de-masking for any attacks in KFE threat spectrum. b. High risk: a dosage > EC _{t16} occurred after de-masking for some attacks in KFE threat spectrum. c. System alarm means that BW agent was identified in at least 2 samples that were automatically collected by biological point detectors.				



Masking Guidance Conclusions

- Masking is like using sun screen
 - If put on ***before*** exposure you won't get burned
 - The sooner it's put on ***during*** exposure, the less likely you are to get burned
 - Putting on ***after*** burn can prevent additional insult
- Masking after two auto-IDs (performed by Portal Shield) can reduce risk to base personnel
 - If masking is delayed until further testing is performed (manual IDs), the benefit of masking is minimal



De-masking Guidance Conclusions

- De-masking from 1 to 5 hours after a weapon or detector event mitigates the risk to personnel that are not already infected; additional casualties are possible
- Specific de-masking guidance will depend on:
 - The type of attack (TBM or sprayer)
 - Whether or not the attack is detected
 - Which agent is identified (if any)
 - Ops tempo (tolerance for risk)



Possible Follow-on Analyses

- Expand guidance to include agent and weather-specific de-masking guidance
- Account for casualties incurred prior to masking
- This analysis evaluated the inhalation hazard *in the vicinity of each detector*; more relevant is the hazard *in the vicinity of airbase personnel*
- Masking guidance should be integrated for both BW *and* CW



Questions

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